

THURSDAY, JANUARY 7, 1892.

INDIAN METEOROLOGY.

Report on the Meteorology of India in 1889. By John Eliot, M.A., Meteorological Reporter to the Government of India. Fifteenth Year. (Calcutta: Government Press, 1891.)

Reports on the Administration of the Meteorological Department of the Government of India, 1885-1891. (Calcutta, Government Press.)

MR. ELIOT'S Report on the meteorology of India in 1889 is much more than a mere mass of statistics, the raw material for future utilization—more than a retrospective summary of the weather phases and incidents of the year, which may or may not be turned to future account by someone gifted with that scientific imagination that alone can infuse life and meaning into the dry bones of our voluminous weather records. These, indeed, it gives with the usual fulness—not in the fragmentary fashion of a gallery of cabinet studies, but with something of the continuity and breadth of a diorama; and over and above these, it deals with many topics of general interest, which are real and valuable contributions to the body of the science, and on which the remarkably favourable conditions of India—a great tropical country dotted over with a well-organized system of observatories under the direction of a competent physicist—are peculiarly fitted to throw light.

Foremost among these, stands the question of the incident solar heat, which is at once the most important, and at the same time one of which we have the least exact knowledge. To this question more attention has been given by the Meteorological Department of India than by that of any other country; and if we must regretfully admit that the results bear but a small proportion to the labour expended on obtaining them, the experience gained of the difficulties attending the inquiry is not without its value.

Some years ago it was thought that the position of Leh, in the dry climate of Western Tibet, 11,500 feet above the sea, offered peculiar facilities for obtaining trustworthy measurements of the solar heat; and in 1882, Sergeant Rowland, a highly intelligent officer of the Royal Engineers, was selected in England, and after a year's careful training at Roorkee in the use of Balfour Stewart's actinometer, under the personal superintendence of Mr. J. B. N. Hennessey, was despatched to Leh, together with a European assistant, who had been equally trained to the work. They were furnished with elaborate instructions, drawn up by Mr. Hennessey, which contemplated observations of two classes. On all clear days observations were to be taken at noon, and also once in the morning and once in the afternoon, with the sun at certain definite altitudes; and on certain selected days (from one to six in each month) similar observations were to be taken at short intervals in succession during so many hours as the altitude of the sun should exceed a certain assigned minimum. The observers remained at Leh nearly two years, and undoubtedly accomplished all that

it was possible to do under the circumstances of the climate; but this proved to be little, if at all, superior to that which might have been obtained at some of the easily accessible stations of the outer Himalaya, and the total outcome of the twenty-three months' work was seven complete series recorded at short intervals, and sixty of of the tri-daily measurements, together with fifteen incomplete series of the former and ninety-five of the latter, which had been more or less interrupted by the obscuration of the sky. Moreover, the instrument by no means answered to the expectations of the inventor. Its chief apparent recommendation was the simplicity of its manipulation; but it was found to require careful attention to a number of minute and elaborate details in order to insure that the observations should be comparable *inter se*, and although the registers obtained were examined and discussed by Prof. Balfour Stewart shortly before his death, they were not found to lead to any definite conclusions of such importance as to justify their publication.

Notwithstanding the discouraging results of this expedition, the investigation has not been abandoned. After Sergeant Rowland's return from Leh, actinometric observations were carried on during the clear season at Mussoorie, and lately under Mr. Eliot's supervision at Simla, and the late Prof. Hill was engaged in the examination of some of this later work, when it was brought to a standstill by his premature death. It is, we believe, now contemplated to make actinometric and other physical observations a part of the future work of the Madras Observatory, and with that view, and also in the interests of astronomy, to transfer the Observatory to some suitable site on one of the lofty hill-groups of Southern India, a step long since recommended on general grounds.

From the first establishment of the Indian Meteorological Department, the sun-thermometer *in vacuo* has formed part of the equipment of every observatory; and every instrument, before being issued, has been subjected to a prolonged comparison with an arbitrary standard, in order to evaluate the mean effect of those irregularities which affect the readings of all instruments of this class, and in many cases amount to differences of 15° and more between thermometers constructed by the best makers. This precaution, however, has proved inadequate. It has long been known that the average readings of many of these instruments undergo a considerable decline in the course of a few years, and that in many cases the glass of the inclosing jacket becomes gradually opaque. During the year 1889, twenty-four observatories were each provided with three carefully compared instruments of different ages, and the observers were instructed to take the observations as accurately as possible. Mr. Eliot says:—

"The results of the three instruments exposed under identical conditions were in the great majority of cases so widely discrepant as to show that the instrument, from defects in its construction, cannot, at least under the conditions of its employment in India, be relied upon to give consistent and reliable results."

The late Prof. Hill subjected these registers to a critical examination, and his conclusions, being based on the results of seventy-two instruments, may be taken as fairly

representing the average behaviour of thermometers of this class. He says :—

“A few days’ observations under identical conditions are not sufficient to determine the correction with any approach to accuracy. The thermometers are so variable in their indications, that, in one ordinary case that I worked out, it would seem that at least forty-four months’ comparative readings would be required to furnish an average correction with a probable error of only one-tenth of a degree. The differences between the indications of two thermometers placed side by side are in very many instances subject to an annual variation, showing that the correction to a common standard cannot be made by adding or subtracting a fixed quantity, but that the amount of this correction is variable, and perhaps capable of being expressed as a function of the temperature indicated. The older instruments, even after correction, on the whole give lower readings than the new ones. Some of the latter, when compared with the oldest thermometers of the set, appear to fall off considerably in sensitiveness even in the short period of twelve months. . . . But sometimes an instrument two or three years old decreases in sensitiveness more rapidly than a perfectly new one; sometimes also an instrument, after remaining nearly constant in its indications for several months, as compared with the oldest of the set, suddenly shows a rapid and unaccountable falling-off in sensitiveness.”

And he concludes :—

“The indications of the instruments are thus in most cases totally unreliable, and the observations comparatively worthless. The only possible exceptions I can see to this sweeping condemnation are observations made with instruments which have been in constant use for ten years or more, and which may perhaps be assumed to have arrived at a constant condition as regards sensitiveness.”

Since the average duration of a sun-thermometer, under the conditions of Indian observatories, is only about three years, it is obvious that instruments that have stood the prescribed test can be but few. But it was with such a thermometer that were obtained the valuable results published by Mr. Hill in the *Journal of the Asiatic Society of Bengal* in 1883 and 1886, which afford the only direct evidence yet on record of an eleven-year variation of the solar heat.

The duration of sunshine has now been recorded at five Indian Observatories with the Stokes-Campbell sunshine recorder for periods of from four to seven years, and the average results are given in Mr. Eliot’s Report, together with those of the year 1889. The stations are all in Northern India, one only, Calcutta, being within the tropics. Allahabad and Lahore show the highest proportion of sunshine, viz. 69 and 68 per cent. respectively of the possible maximum. Jeypore has but little less, viz. 65 per cent. Calcutta follows with 59 per cent., and Dehra, at the foot of the Himalayas, shows the lowest average, viz. 49 per cent. At St. Aubin’s, in Jersey, the sunniest station in the British Isles, the proportion is 39 per cent. In the absence of any record from Southern India, it cannot be positively asserted that the Indo-Gangetic plain is the sunniest portion of India, but judging from the registers of cloud proportion, which are regularly kept at all Indian stations, there can be but little doubt that such is really the case.

Another kind of observations nearly related to the above are those of the temperature of the ground. These

NO. 1158, VOL. 45]

have been made at the same five Observatories that have furnished the sunshine records: at Calcutta since 1878, and at the other stations during periods of from four to ten years. One feature is common to all of them. In all cases the mean temperature of the ground is some degrees higher than that of the air, the excess varying, however, considerably at different stations, and at the same station in different years, as well as, of course, at different seasons of the year. This general fact was observed many years ago by the late J. Allen Broun at Trevandrum, and has also been known for some years in the case of Calcutta and Allahabad; and it was remarked by the late Prof. Hill that it is probably characteristic of hot climates in general. He considered it probable that there is

“a difference in the opposite direction between the air and ground temperatures in high latitudes; for, owing to the circulation of the atmosphere, and the constant mixing together of its several parts, the air temperature must be more uniform all over the earth than it would be were it determined for each place solely by the balance between insolation and loss of heat by radiation into space; while the temperature of the ground is more directly dependent on the balance between the gain and loss of heat by radiation.”

I am not aware that this interesting speculation has hitherto been verified.

According to the present registers, Jeypore (where the ground consists of loose dry sand) shows the greatest excess of ground surface temperature, viz. $6^{\circ}3^1$ on the mean of the year; and at Lahore (where the ground is a sandy loam) it is as much as $5^{\circ}8$. At Allahabad it appears to be about $3^{\circ}8$, and at Calcutta $2^{\circ}7$. It is therefore in a great measure dependent apparently on the dryness of the climate, since the mean annual rainfall of these four places is 25, 21, 38, and 62 inches respectively, and the mean relative humidities 50, 50, 61, and 77 per cent. of saturation. The ground temperatures here considered are those of the surface. At Calcutta the temperature increases rapidly with the depth, so that at 3 feet deep it is $1^{\circ}5$ warmer than at the surface, and at 6 feet $1^{\circ}6$ warmer. This is probably to be attributed to the decomposition of organic matter, with which a bed of foetid quicksand at a depth of 40 or 50 feet is highly charged, and which, when freshly excavated, is distinctly warm to the touch.²

At other stations there appear to be some remarkable irregularities in the temperatures at different depths. Thus at Allahabad the average warmth of the ground decreases $1^{\circ}7$ between the surface and the depth of 1 foot, and then increases $1^{\circ}2$ to a depth of 3 feet; at Jeypore it decreases $3^{\circ}3$ down to 1 foot, and then increases, but somewhat irregularly, by a total amount of $0^{\circ}6$ to a depth of 20 feet; and at Lahore it decreases $1^{\circ}5$ to a depth of 1 foot, and increases again $0^{\circ}7$ to 3 feet. In the case of Allahabad, the temperatures of which were fully discussed in a memoir by the late Prof. Hill,³ some of these minor irregularities

¹ Most of the figures quoted in this paragraph differ from those given in Mr. Eliot’s Report. In the Report the comparison is made between the mean ground temperature of a few years and that of the atmosphere deduced from three or four times as many, and in some cases the conditions of the Observatory have been changed. The figures in the text are derived from a comparison of the same years.

² This bed extends apparently everywhere beneath Calcutta, and is the cause of great instability to the more ponderous edifices, of which the great Imperial Museum affords a striking example. In fact, in a certain sense, Calcutta may be said to be a floating city.

³ *Indian Meteorological Memoirs*, vol. iv., Part iii., No. v., “On the Ground Temperature Observations made at the Observatory, Allahabad.”

were shown to be the result of the flux and reflux of waves of heat as hotter or colder years alternated, the effects of which were by no means eliminated in the five or six years over which the record extended. But the remarkable diminution of temperature from the surface down to 1 foot cannot be thus explained. It appears at all the stations, for even at Calcutta there is an increase of only $0^{\circ}2$ in the first foot below the surface, and then an increase of $1^{\circ}3$ between 1 and 3 feet; and it appears to be independent of the character of the surface, which at Calcutta is grassy, and at Jeypore pure sand absolutely without vegetation. At Calcutta and Allahabad, the 1-foot thermometer as originally installed was found to have its temperature lowered by air-convection at night in the tube around the thermometer; but steps were taken to prevent this both at these and the other Observatories, and the invalidated registers were rejected. Yet it is difficult to imagine the existence of any cooling agency which should keep the temperature at 1 foot below the surface on an average 1° or 2° lower than either above or below that level, and the matter certainly requires further investigation.

The foregoing remarks deal with subjects which, although intimately connected with meteorology, lie somewhat apart from the ordinary field of meteorological observation. There is, however, very much in Mr. Eliot's Report, on the more familiar class of subjects usually dealt with by meteorologists that is well worthy of reproduction, especially the characteristic phenomena of Indian storms, which Mr. Eliot has made the object of his special study. These must be reserved for another notice.

The frequent reference in the foregoing paragraphs to the admirable work of the late Prof. Hill (and, after all, but few of the many subjects have been noticed to which his active mind contributed so largely) forcibly brings before me how great a loss has been sustained by Indian science in his premature death—a loss the more conspicuous in a country where the workers are so few and the field of research so large and fruitful. It is but a sad consolation to offer this slight tribute to the memory of a man who was as modest and amiable as he was able and accomplished as a devotee of science; but all who know his work will cordially re-echo the words of the Governor-General in Council—that the Meteorological Department of India “lost in him an officer whose industry, talent, and technical knowledge it will be hard to replace.”

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FRENCH MALACOLOGY.

Les Coquilles marines des Côtes de France; description des familles, genres, et espèces. Par A. Locard. Pp. 384; 348 Figures in Text. (Paris: Baillière, 1892 [or rather 1891].) Also issued as tom. xxxvii. (1891) of the *Annales de la Société Linnéenne de Lyon*.

MORE favourably situated than these isolated and comparatively chilly shores, France possesses a Molluscan fauna which numerically is richer far than ours; whilst her political boundaries embrace portions of two terrestrial regions and two marine Molluscan provinces.

The land regions (Germanic and Lusitanian) yield probably something under 300 species. The last trustworthy work, that by Moquin-Tandon, describes 266 species—219 being terrestrial and 47 fresh-water forms.

The marine provinces are the Celtic and Lusitanian. The former includes the greater portion of the English Channel, and is common ground, therefore, to ourselves and our neighbours. The latter, especially the Mediterranean as distinguished from the Atlantic version of it, furnishes the French conchologist with his happiest hunting-ground. Nearly 1200 species are to be found in the Mediterranean, and another 150 (besides 418 common forms) on the Atlantic coast.

In contrast with this abundance of Molluscan life, all that we can boast is some 550 marine and 130 non-marine species.

Whilst, however, the material obtainable by the French conchologist is thus plentiful, the literature at his disposal for purposes of research and identification is by no means so complete as that which lies ready to the hand of his British *confrère*. The French Forbes and Hanley, or even Jeffreys, has yet to be compiled; no single work exists giving adequate descriptions, with synonymy, notes, and figures.

For the non-marine species Moquin-Tandon's careful work remains unsurpassed: for the whole subject the only approach yet made consists of the three volumes by M. Locard, of which the one now under consideration forms the last. The first two were issued under the title “*Prodrome de Malacologie Française, Catalogue général des Mollusques vivants de France*,” and dealt respectively with the land, fresh- and brackish-water Mollusca, and with the marine. In these volumes the author gave no descriptions: a synonymy of each species, with references to the best descriptions and figures, and a list of the French localities, were all that appeared. In the present work M. Locard proposes to supply this deficiency, so far as the shells of the marine testaceous Gastropoda, Pelecypoda, and the Brachiopoda are concerned, by furnishing a concise—mostly too concise—description of each species, and a more detailed description, with a figure, of the typical forms of each genus and section, or “groupe” as he terms it, thereof. The synonymy and the bibliography are not repeated, and so each work remains incomplete without the other, and double reference is entailed—a process which is always vexatious.

Unfortunately, too, the subject is conceived exclusively from a shelly point of view; indeed, the fact that the shells ever had an animal origin and connection, is most skilfully concealed in the body of the work, and the ‘nasty creature’ is only alluded to when, in the introduction, it becomes necessary to refer to its habitat, or to describe the method of its elimination prior to the deposition of the all-precious tenement in the cabinet. To such a point is this persistent ignoring of the animal carried, that, in defining the topography of a bivalve shell, the customary and intelligible terms “right” and “left valve” are discarded in favour of the arbitrary designations of “upper” and “under,” a nomenclature derived from their position when the shell is placed on its side upon the table with the umbones pointing towards the left.